

**REMARKS**

New claims 46-76 have been added. Claims 46-75 are all directed to narrow species within the scope of previously examined claims. That is, they are all directed to species of claims 1, 12, 18, 20, 21, and 32 in which the CTE modifying component defined therein specifically comprises molybdenum.

Support for new claims 46, 54, 56, 58, 64, and 70 can be found, for example, at page 9, line 21 of the specification.

Support for new claims 47 and 48 can be found, for example, at page 10, lines 9-14 of the specification.

Support for new claims 49, 55, 57, and 71 can be found, for example, at page 13, line 22 of the specification.

Support for new claims 59 and 65 can be found, for example, at page 19, line 23 of the specification.

Support for new claims 50-53 can be found, for example, at page 7, lines 2-5 of the specification.

Support for new claims 60-63 and 66-69 can be found, for example, at page 18, line 28 to page 19, line 1 of the specification.

Support for new claims 72-75 can be found, for example, at page 20, lines 22-26 of the specification.

Support for claim 76 can be found, for example, at page 10, line 23 to page 11, line 3 of the specification.

Claim 20 has been amended to correct a typographical error.

No new matter is being introduced by the present amendments.

Upon entry of this amendment, claims 1-6, 8-12, and 14-76 will be pending in the application.

**Allowed and Allowable Subject Matter**

Applicants acknowledge allowance of claims 12 and 14-45. New claims 54 to 75 depend directly or indirectly from one or

more of these claims and, thus, applicants respectfully request allowance of these claims as well.

Applicants further acknowledge the indication of claims 2, 3, 5, 6, and 8-11 as allowable. Applicants respectfully submit these claims are patentable over the cited references for the reasons set forth below concerning claim 1 and based on the additional limitations appearing therein.

**Rejections Under 35 U.S.C. §103(a)**

Reconsideration is respectfully requested of the rejection of claims 1 and 4 under 35 U.S.C. §103(a) based on the disclosure in U.S. Patent No. 6,312,535 to Leatham et al.

Independent claim 1 has three requirements:

(1) a thermal interface material for bonding components of electronic devices, where a solder component and additive uncoated CTE modifying component are constituents of the thermal interface material;

(2) the uncoated CTE modifying component has a coefficient of thermal expansion that is less than about 10  $\mu\text{m}/\text{m}^\circ\text{C}$  as an additive;

(3) the solder component comprises a bonding component selected from the group consisting of In, Sn, Cu, Pb, Sb, Au, Ag, alloys thereof, Bi alloys, and mixtures thereof.

Each of these is an affirmative requirement that cannot be ignored in assessing patentability of claim 1 in view of Leatham et al. A requirement of this combination is, expressly, that the CTE modifying component (such as SiC,  $\text{SiO}_2$ , etc.) and the bonding component are co-constituents of the thermal interface material used to bond electronic device components.

Leatham et al. describe electronic packaging materials "comprising" the Si-based alloy they describe (see, column 5,

lines 41-44). They describe the alloys as constituting stand-alone components:

The invention also includes a microelectronic packaging material comprising an alloy as aforesaid. The alloy material is normally cut and machined into a packaging component of desired configuration or it may be semi-solid formed. In addition to electronic applications, the alloys can also be used for structural applications where there is a requirement to match the CTE with other materials and to reduce weight. Rapidly moving robotic components are another potential application. Col. 5, lines 40-48.

Something that is "cut and machined into a packaging component" is a stand-alone component, not a constituent of a thermal interface material. The alternative proposal to use the alloy "for structural applications" is stated to be "in addition to electronic applications," and juxtaposed to "robotic components," so it does not appear to be relevant to applicants' claim 1 for "a thermal interface material for bonding components of electronic devices." In any event, the suggestion that "the alloys can also be used for structural applications" similarly implies stand-alone components. And regardless of what it does imply, it wholly fails to suggest using the alloys as additives with an In, Sn, Cu, Pb, etc. bonding component as co-constituents in the formulation of thermal interface materials.

The failure of the reference to suggest a thermal interface material (TIM) for bonding, where the TIM has a bonding component and a CTE modifying component is underscored by review of the reference as a whole. In column 4 they describe spray-depositing a Si-Al alloy, its solidification, and resulting phases. Nowhere in column 4 do they suggest this Si-Al product should be used as a co-constituent with an In, Sn, Cu, Pb etc. bonding component to form a TIM to bond electronic components. Then beginning at the bottom of column 4 through the top of

column 5 they suggest adding SiC particles to accompany the Si and Al in the atomizing spray used to make the deposit. And in the middle of column 5 they describe alternatives of Si-Al with SiC, Mg, Cu, Fe, and/or Zr. But there is still no suggestion the Si-Al-SiC-etc. product should be used as a co-constituent with an In, Sn, Cu, Pb, etc. bonding component to form a TIM to bond electronic components. The remainder of the reference discusses the alloy properties, and similarly fails to suggest using the alloy as a co-constituent with an In, Sn, Cu, Pb, etc. bonding component to form a TIM to bond electronic components.

A further requirement of claim 1 not suggested by Leatham et al. is that the CTE modifying additive incorporated into the thermal interface material is uncoated (i.e., not pre-wet). Leatham et al. do not give any details of how to incorporate their alloy as an additive into anything; so they necessarily fail to disclose any particular manner -- coated or uncoated -- of incorporation of the silicon-based alloy into a TIM.

Moreover, since Leatham et al. do not suggest using their alloy as an additive with any bonding components as co-constituents of a TIM, they necessarily fail to disclose or suggest applicants' requirement for a bonding component selected from the group consisting of In, Sn, Cu, Pb, Sb, Au, Ag, alloys thereof, Bi alloys, and mixtures thereof.

In view of Leatham et al.'s failure to suggest the foregoing requirements, claim 1 is patentable thereover.

With regard to the assertion in the Office action that Leatham et al. disclose solder joint connections with additives, applicants respectfully request the examiner to reconsider. Leatham et al.'s reference to solder joint connections is as follows:

Furthermore, thermal mis-match between the electronic components and the heat sink to which they are

attached must be minimized in order to prevent stressing and subsequent failure of the brittle electronic devices and/or solder joint connections.  
Col. 1, ln. 30 ff.

In particular, they attribute failure of solder joints to mismatch between *electronic components* and *the heat sink*. They do *not* attribute the failure to any characteristic of the solder joint. So the assertion in the Office action that Leatham et al. are somehow suggesting additives -- "Leatham '535 discloses ... solder joint connections ... having an additive component such as Si<sub>x</sub>Al alloys ..." -- to adjust characteristics of the joining material is an extrapolation without any technical basis in the reference.

Since the cited reference does not teach or suggest each claim limitation, applicants respectfully submit claim 1 is patentable thereover.

Claim 4 specifies that the additive component further comprises a thermal conductivity enhancement component selected from the group consisting of Al, Ag, Cu, Al-coated Cu, Au, AlN, BeO, BN, high conductivity cermets, cuprates, silicides, carbon phases, and mixtures thereof. That is, the thermal interface material of claim 4 includes a thermal conductivity enhancement component along with the additive defined in claim 1. As noted above, Leatham et al. do not disclose or suggest additional components to be incorporated into electronic packaging materials along with a silicon-based alloy. Thus, the reference cannot be said to disclose a thermal conductivity enhancement component as required in claim 4 to be incorporated in a thermal interface material along with an additive comprising a CTE modifying component. In any event, the lone alloy specifically disclosed and exemplified by Leatham et al. is a silicon-aluminum alloy. Contrary to the assertion at page 3 of the

Office action, such a material does not appear in the list set forth in claim 4. The only mention of any of the thermal conductivity enhancement components set forth in claim 4 (e.g., AlN) is found in the comparison of the Leatham et al. silicon-aluminum alloy to other materials set forth in Tables 2 and 3 of the working examples. But applicants note that the silicon-aluminum alloy is also relied on by the Office as the additive of claim 1. So even if this alloy was included in the list of claim 4, an affirmative limitation of claim 4 (i.e., an additive as required in claim 1) would be lacking. Thus, applicants respectfully submit claim 4 is patentable over the disclosure of Leatham et al.

Based on the foregoing, applicants respectfully request withdrawal of the rejection of claims 1 and 4, and withdrawal of the objections to dependent claims 2, 3, 5, 6, and 8-11.

New claims 46-53

Applicants respectfully submit that new claims 46-53, which depend directly or indirectly from claim 1, are patentable over the cited reference for the reasons set forth above concerning claim 1 and based on the additional limitations appearing therein.

New claim 76

New claim 76 depends from claim 1 and requires that the CTE modifying component does not include any wetting-enhancing component. Applicants respectfully submit this claim is patentable over the cited reference for the reasons set forth above concerning claim 1, and further distinguishes Leatham et al. based on the specific exclusion of a wetting-enhancing coating.

CONCLUSION

In view of the above, favorable reconsideration and allowance of all pending claims are respectfully solicited. Upon entry of this amendment a total of 74 claims (7 of which are independent) will be pending in the application. Applicants hereby authorize the Commissioner to charge Deposit Account No. 19-1345 for the excess claims fee of \$1550 due with submission of this Amendment.

The Commissioner is requested to charge any fee deficiency or credit any overpayment to Deposit Account No. 19-1345.

Respectfully submitted,

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**VIA EFS**